Surface-Soil Properties in Response to Silage Cropping Intensity under No Tillage on a Typic Kanhapludult

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Rationale

- ***Soil quality*** is a concept that determines the management implications on soil ecosystem functions.
- Soil ***organic components*** are important in providing energy, substrates, and biological diversity to sustain functions.
- ***Conservation tillage*** systems can likely contribute to improvement in soil quality.

Rationale

- ✔ Crop residues returned to soil should alter soil organic matter accumulation and the success of a conservation tillage system.
- ✔ Dairy producers rely on high-quality feedstuffs using silage.
- ✔ High-intensity silage cropping offers little residue to buffer against equipment traffic.

Objective

- ✔ Quantify the impact of alternative, reduced-silage-cropping intensity systems on surface-soil properties, including
  - bulk density
  - aggregation
  - organic C and N
  - microbial biomass C
  - mineralizable C and N
- ✔ We considered the soil surface a critical zone, and therefore, focused our efforts on the surface 3 cm of soil.

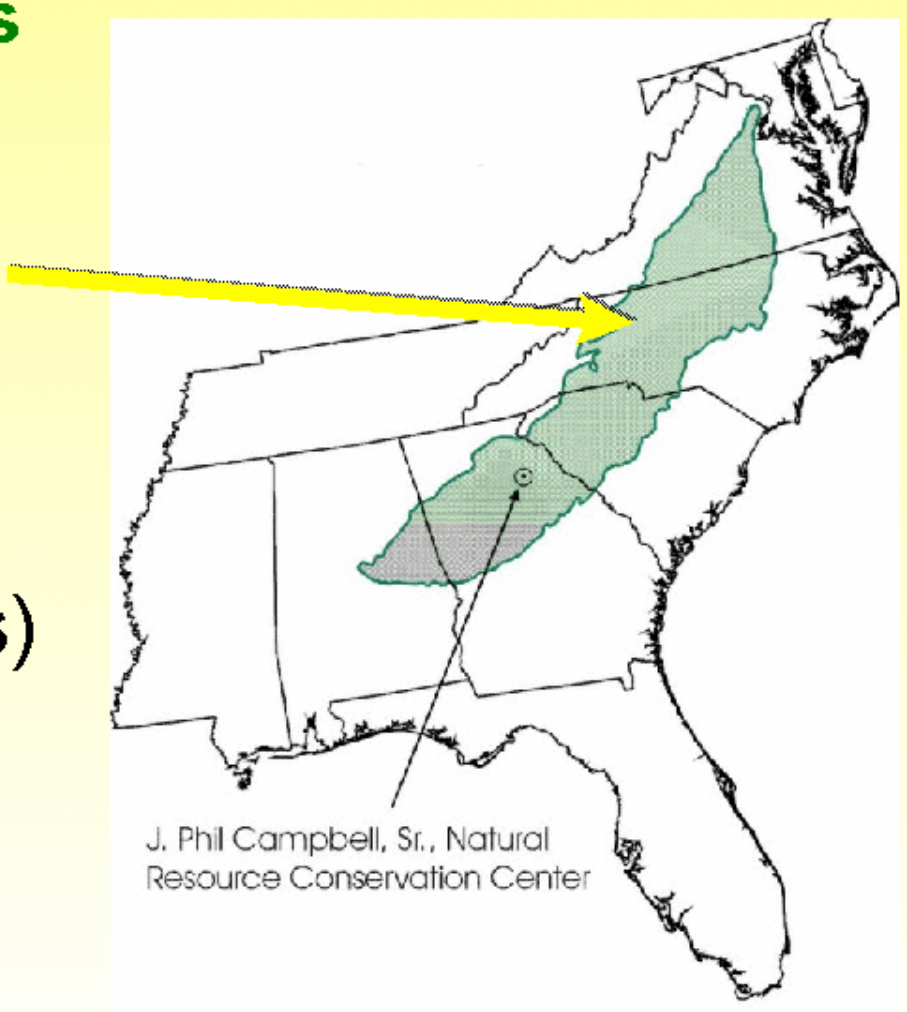
Methods

Location and characteristics

Dairy farm in the Southern Piedmont region of North Carolina USA

Soils – loam to sandy clay loam (Typic Kanhapludults)

Precipitation – 122 cm
Temperature – 14.4 C



Methods

Field design

- ✔ Three cropping systems under no tillage, replicated twice in 300-m-long strips 15-25-m wide

Silage Intensity	Residue Return	Silage/Year	Year 1	Year 2
High	Low	2	Maize silage Barley silage	Maize silage Barley silage
Medium	Medium	1	Maize silage Rye cover	Maize silage Rye cover
Low	High	0.5	Maize silage Barley grain	Sudan cover Rye cover

Methods

Sampling

When

At 1, 2, 3, 4, and 5 years from treatment

Where

8 locations per plot

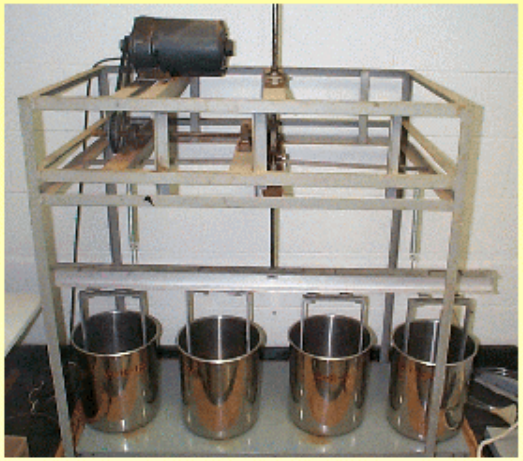
How

Surface residue from 20 x 20-cm areas

Soil from 4-cm diam cores at 0-3, 3-6, 6-12, 12-20 cm; dried at 55 C; sieved <4.75 mm

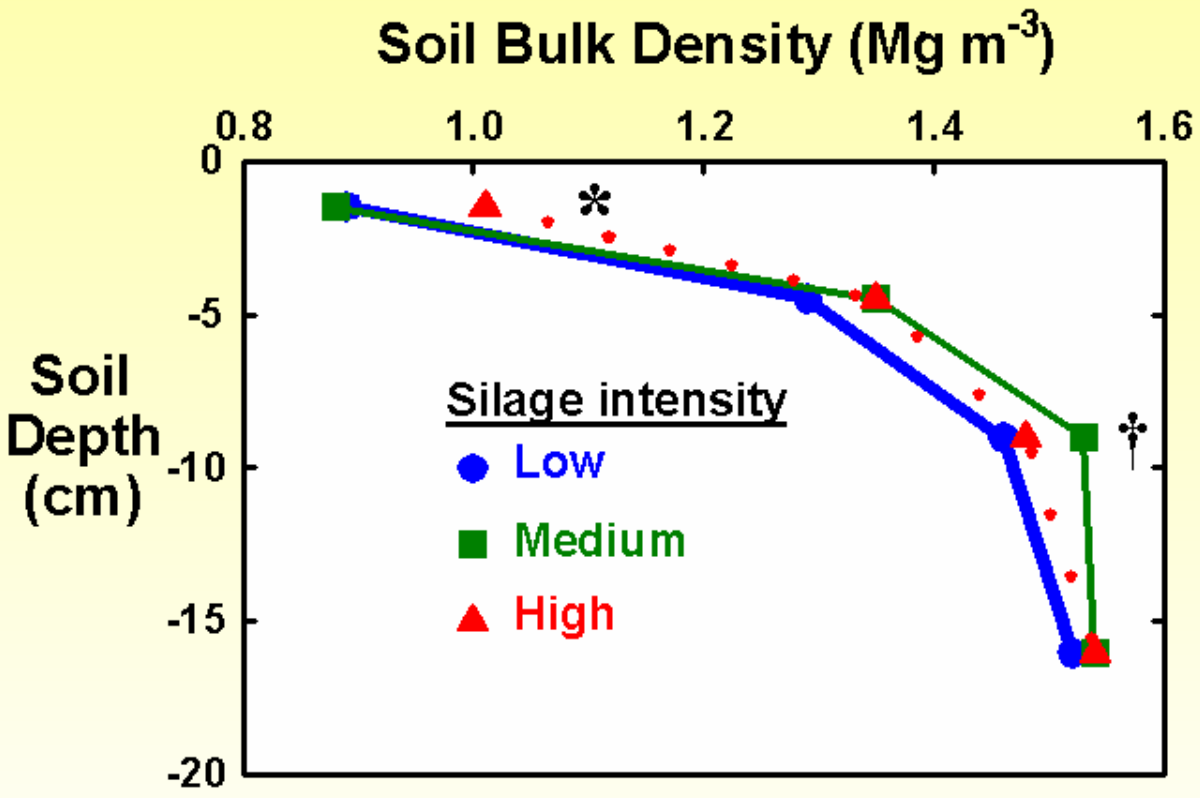
Methods

Analyses



- ✔ Soil bulk density
  - Weight, volume of cores
- ✔ Soil aggregation
  - Mean-weight diameter (MWD) of water-stable fractions
  - Stability from wet MWD / dry MWD
- ✔ Soil organic C and N
  - Dry combustion
- ✔ Soil microbial biomass C
  - Chloroform fumigation-incubation

Results



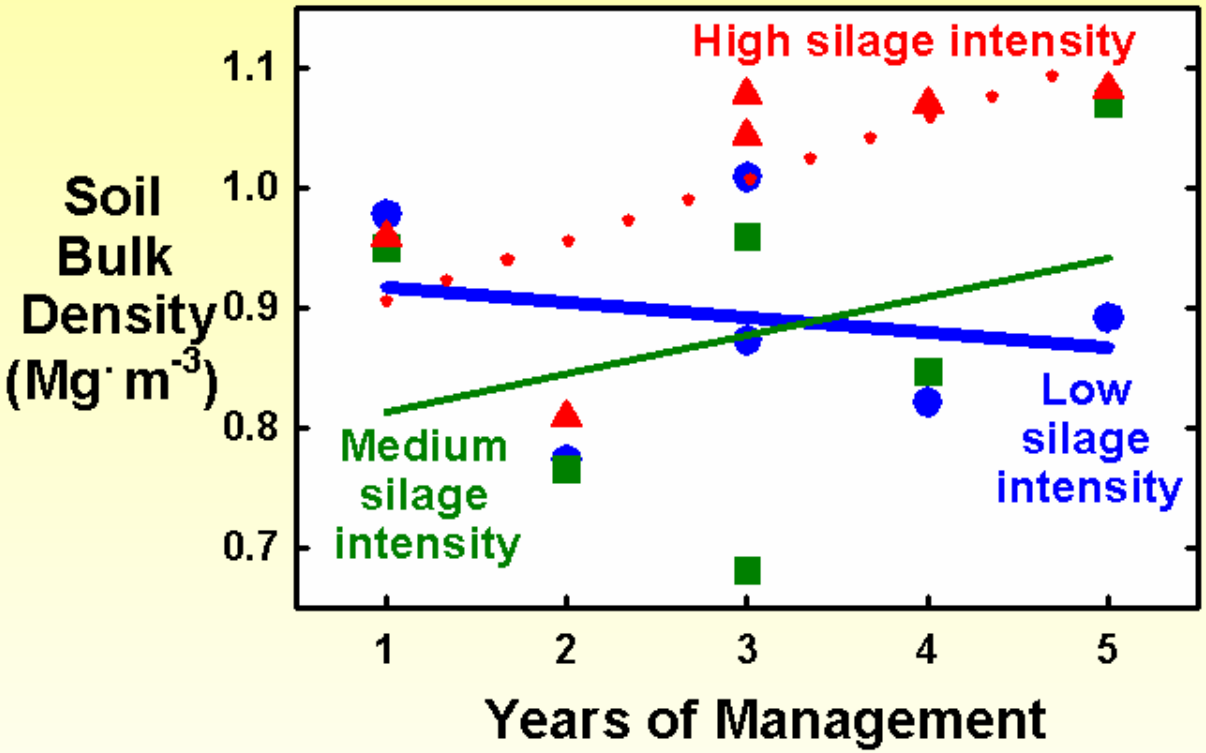
Averaged across sampling events, bulk density was lowest at the soil surface.

Low silage intensity (highest residue returned) had lower bulk density, especially at the soil surface.

Impact

More surface residue reduces bulk density.

Results

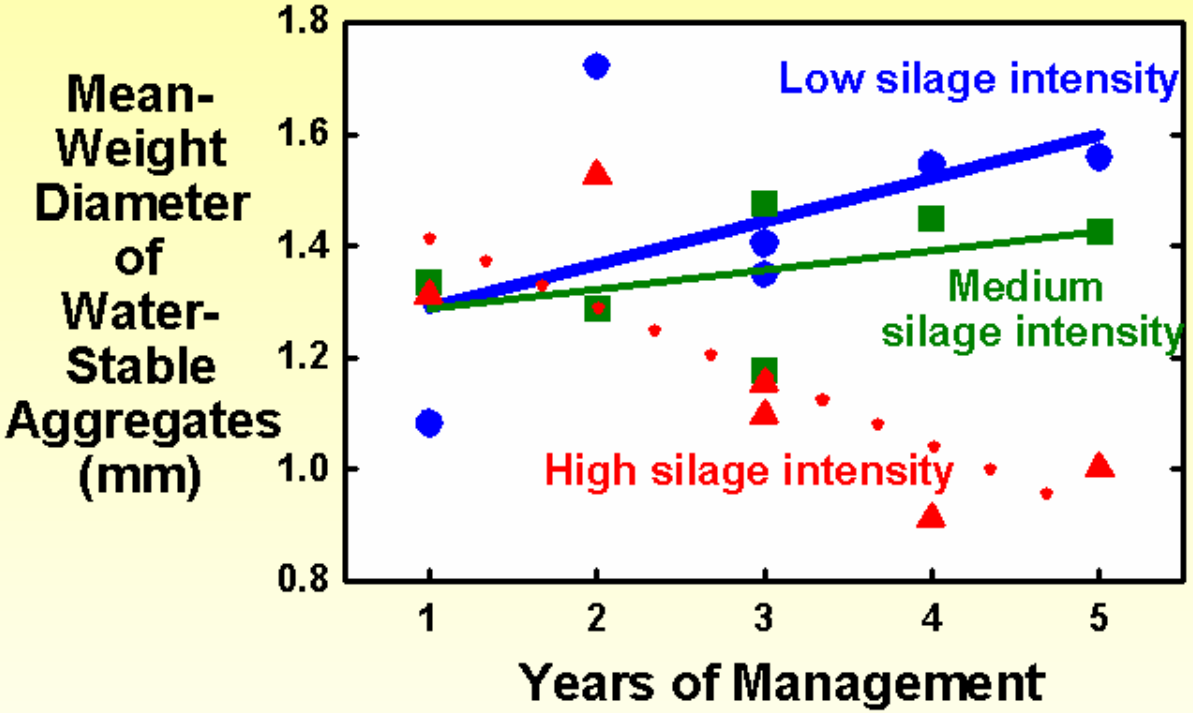


In surface soil (0-3 cm) bulk density diverged with time between low and high silage intensity.

Impact

Avoidance of compaction with heavy equipment and providing sufficient residue cover improves surface porosity.

Results

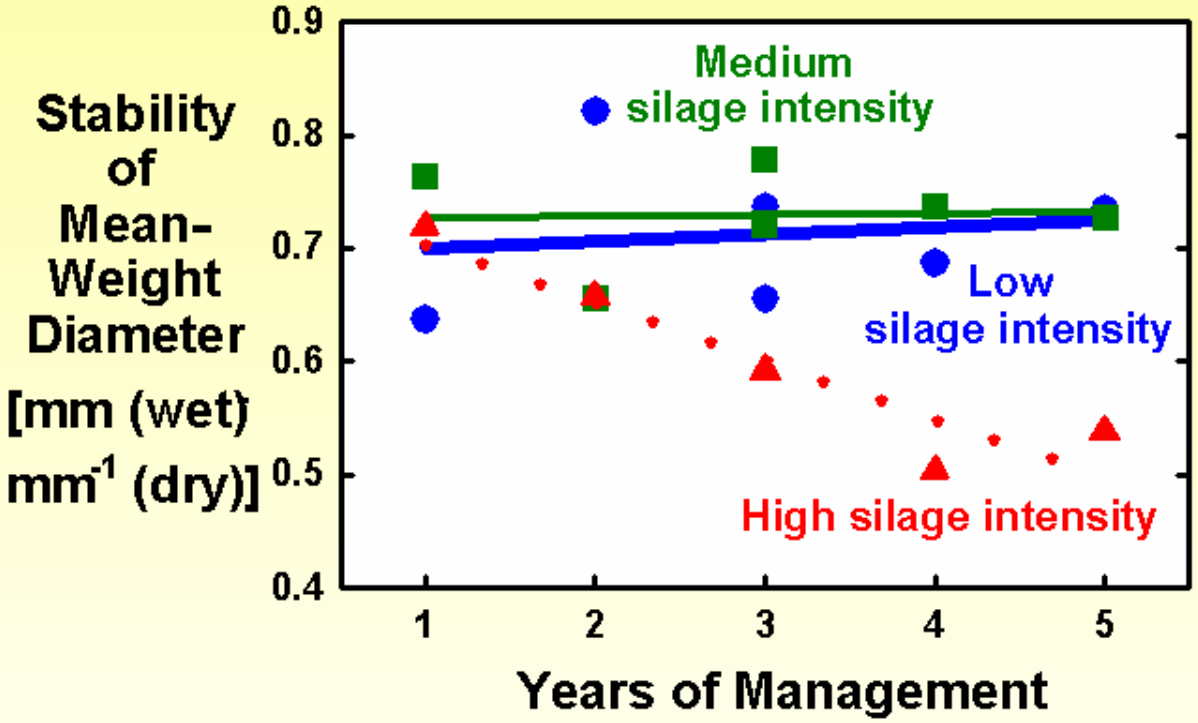


In surface soil (0-3 cm) water-stable aggregation improved with time under low and medium silage intensity compared with the traditional practice of the region (i.e., high silage).

Impact

More surface residue improves resistance to erosion.

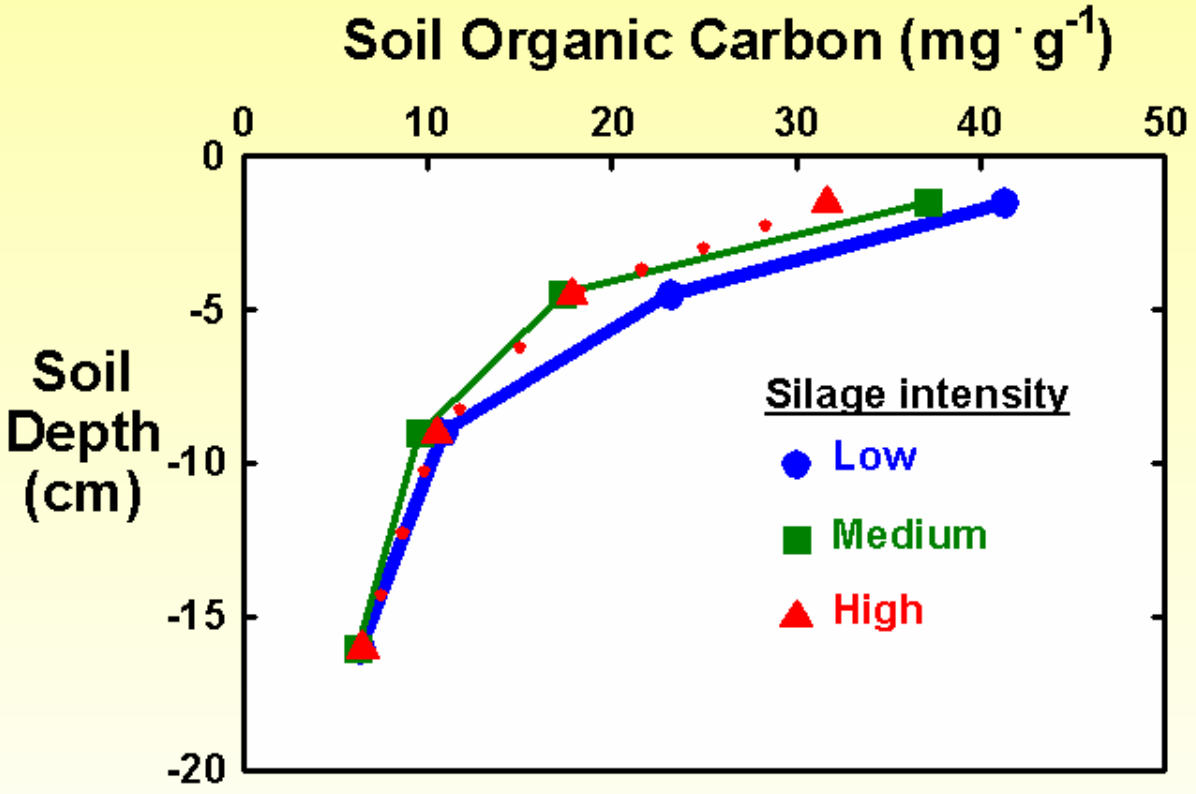
Results



In surface soil (0-3 cm) stability of aggregates declined with time under high silage intensity, but remained the same with time under low and medium silage intensity.

Although soils of the region are relatively well aggregated, deterioration without residue input occurs.

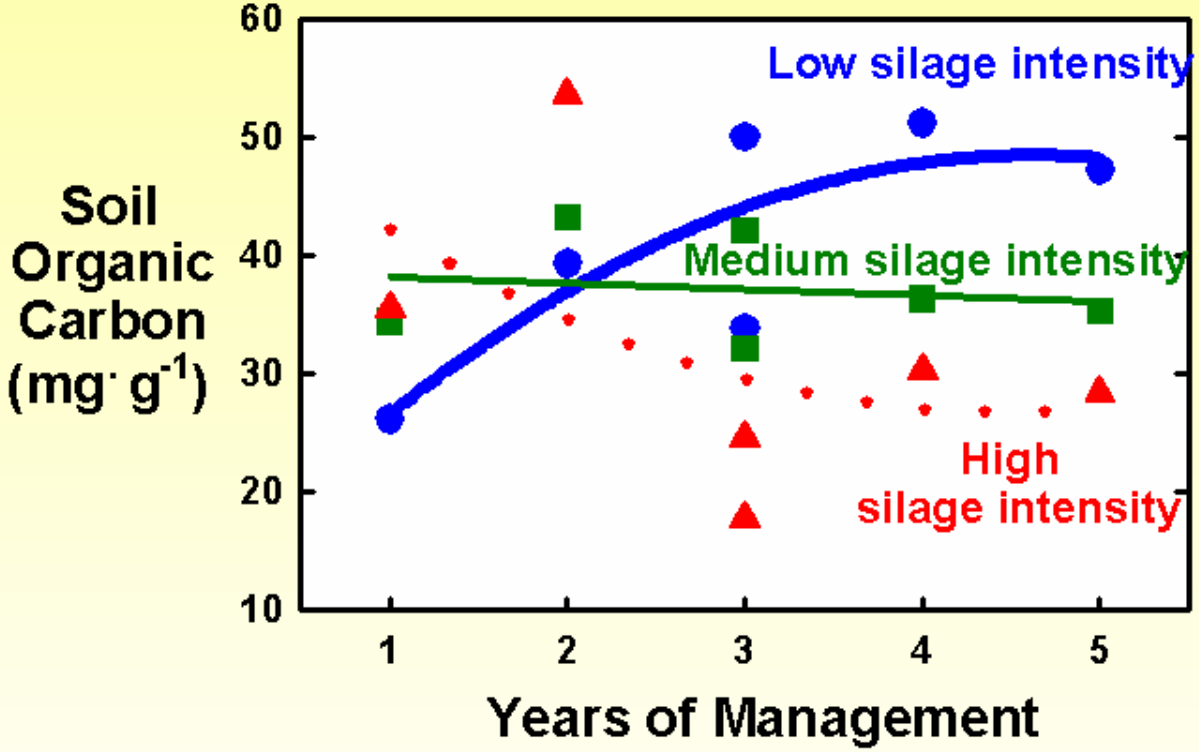
Results



Averaged across sampling events, soil organic C was greatest at the surface and declined with depth.

Although no statistical differences occurred, trends near the soil surface were inversely related to silage intensity.

Results

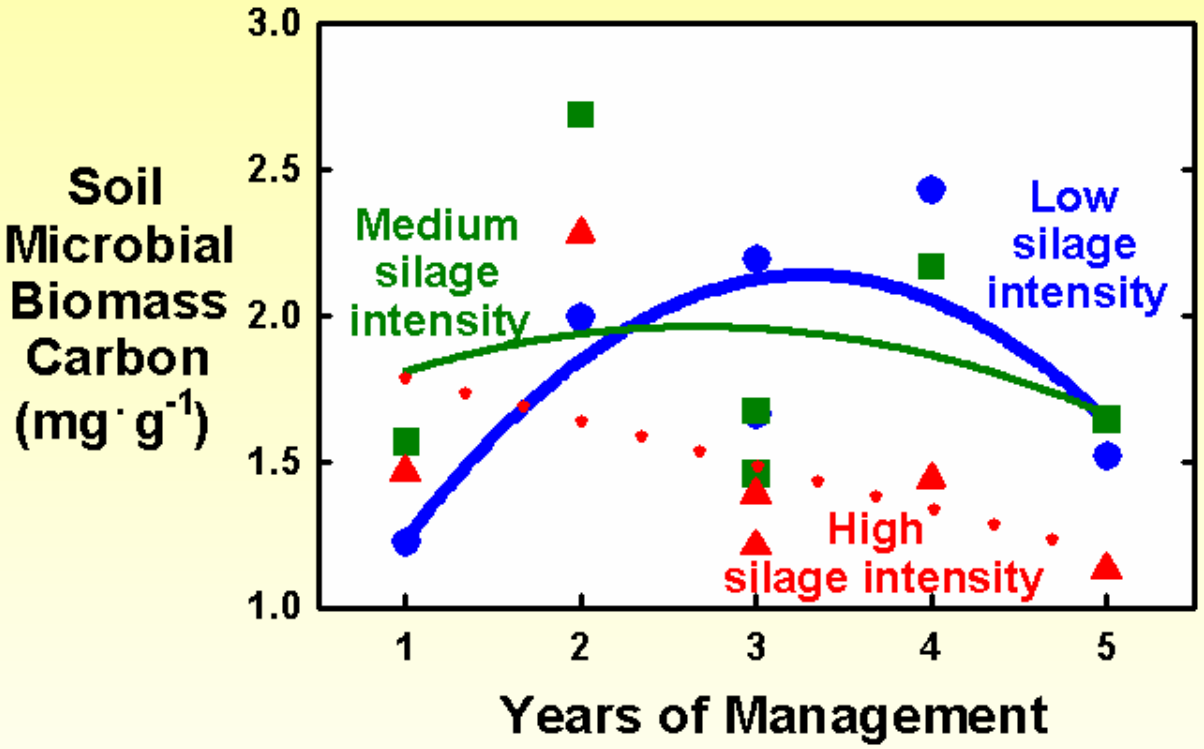


In surface soil (0-3 cm) soil organic C increased with time under low silage intensity and decreased with time under high silage intensity.

Impact

More surface residue improves retention of organic matter in soil.

Results



In surface soil (0-3 cm) microbial biomass C doubled during the first 3 years of low silage intensity. This was in contrast with a steady decline in high silage.

Impact

More surface residue enriches total organic C, which improves porosity and water retention, resulting in higher microbial biomass.

Summary and Conclusions

- ✔ Biophysical interactions were important
  - Soil compaction occurred with lack of surface residues
  - Large quantities of crop residue returned to soil with low silage intensity
    - → alleviated compaction with higher soil organic C
    - → improved resistance to soil erosion with better aggregation
    - → created a more conducive environment for soil organisms
- ✔ Benefits from conservation tillage systems are greatest when sufficient surface residues are maintained.